



# An Integrative Review of Sleep Interventions and Related Clinical Implications for Obesity Treatment in Children

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**Purpose** Evidence has shown correlations between obesity and sleep in children. The purpose of this review was to identify sleep interventions that could be utilized in primary care settings to prevent obesity in children.

**Results:** Three themes emerged: bedtime routines and environment; parental presence and graduated extinction; and health education. Effective strategies to improve sleep in children include consistent bedtime routine and self-soothing.

**Conclusion:** Health care professionals can provide innovative and prevention-based sleep education for parents early in a child's development. Education, related to sleep, and appropriate sleep strategies may help prevent obesity and its long-term consequences.

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IN RECENT DECADES, childhood obesity rates have rapidly increased, becoming a growing concern because of their significant health consequences. In the United States, approximately 32% of children and adolescents between the ages of 2 and 19 years were considered overweight or obese in a 2011–2012 study (Ogden, Carroll, Kit, & Flegal, 2014). These data illustrate that the number of overweight and obese children has almost tripled since 1980, when the amount was only 10% (National Center for Chronic Disease Prevention & Health Promotion [NCCDPHP], 2011; Center for Disease Control and Prevention (CDC) (2013)). The physical, mental, and emotional consequences and risks associated with being overweight or obese are well documented. For example, obese children are at increased risk for experiencing cardiovascular disease risk factors (e.g., hypertension or high cholesterol), musculoskeletal problems, sleep apnea, and social and

psychological problems, such as poor self esteem (NCCDPHP, 2011). **Additionally, children who are overweight or obesity (BMI greater than 85th percentile) during the preschool years are five times more likely to be overweight as adults than children of a healthy weight (BMI between 5th and 85th percentile) (CDC, 2013),** thereby increasing their risk of health consequences such as cardiovascular disease, type 2 diabetes, stroke, osteoarthritis, and multiple types of cancer (NCCDPHP, 2011). Therefore, efforts to address the obesity epidemic must emphasize interventions that target lifestyle behaviors **for children and families** in order to address detrimental behaviors before they become a permanent part of an individual's lifestyle.

Interventions to target obesity during childhood have commonly focused on known predictors of weight status including, physical activity, dietary habits, and sedentary activities (Hart, Cairns, & Jelalian, 2011). However, as evidenced by the continuing increase in the numbers of obese and overweight children, new interventions that are innovative, comprehensive, and prevention-based must be

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implemented to more effectively address the epidemic. For example, an increasing body of evidence supports a negative relationship between childhood sleep duration and sleep problems with obesity (Cappuccio et al., 2008; Hart et al., 2011; Landhuis, Poulton, Welch, & Hancox, 2008). Children with shorter nighttime sleep duration have a 58% higher risk of being overweight or obese (Monasta et al., 2010).

As childhood obesity rates continue to increase, nighttime sleep duration has declined across the early lifespan. It has been reported that every additional hour of sleep obtained during middle childhood (i.e., 5 to 11 years of age) reduced the risk of obesity at 32 years of age by 35% (Hart et al., 2011). While sleep during childhood is both essential and critical for health, recommended amounts of sleep do decline with age. For example, infants require 14 to 15 h of sleep per day, and school-age children (5 to 10 years) require only between 10 and 11 h (National Sleep Foundation (NSF), 2014). However, the actual amount of daily sleep among U.S. children remains far lower than the recommended amount. A National Sleep Foundation survey yielded results indicating that nighttime sleep duration has declined on average by 1.5 to 2 h per day in U.S. children (NSF, 2004). **A recent meta-analysis also suggests that actual sleep duration has declined in children by approximately 70 min over the past half century (Matricciani, Olds, Blunden, Rigney, & Williams, 2012; Matricciani, Olds, & Petkov, 2012). This change in trends has been attributed to later bedtimes in children younger than 5 years of age.**

In every age group, almost half of the children included in the survey took over 15 min to fall asleep at night (NSF, 2004). In addition, the average hours slept per night were 9.0 to 9.8 (NSF, 2004), significantly less than the recommended 10–12 h advocated by national organizations (NSF, 2014). Moreover, an estimated 20% to 30% of young children in the United States have significant sleep problems such as resisting going to bed or having difficulty falling asleep (Mindell, Kuhn, Lewin, Meltzer, & Sadeh, 2006).

## Association Between Obesity and Sleep From Infancy to Adolescence

Correlations between sleep duration and sleep problems and short- and long-term weight status among all age groups, from infancy to adolescence, are well documented in the literature. For example, in children between 0 and 4 years of age, a short duration of nighttime sleep is associated with increased risk of obesity or being overweight later in life (Bell & Zimmerman, 2010). In addition, a study of 915 mother–infant pairs demonstrated that infant sleep of less than 12 h per day was predictive of higher BMI scores, skinfold thickness, and odds of being overweight as a 3-year-old (Taveras, Rifas-Shiman, Oken, Gunderson, & Gillman, 2008). In a similar study, children between 2 and 4 years of age with a sleeping problem were 1.90 times more likely to be obese than children without a sleeping problem (Al Mamum et al., 2007).

A prospective study which evaluated sleep duration at four intervals during childhood found that longer sleep durations during childhood predicted lower odds of adult obesity, while children who slept less than 11 h per night, between the ages of 5 and 11 years, had consistently higher BMI scores (Landhuis et al., 2008). Independently, Must and Parisi (2009) reported a similar association between amount of sleep early in life and weight status in young adulthood. Finally, in another study of almost 1500 children, the overall risk of being overweight or obese was 4.2 times higher in children who persistently slept less than 10 h per night until the age of 6 years (Touchette et al., 2008).

In a study of over 8000 U.S. adolescents (aged 13 to 16 years), 16.1% were overweight and 7.2% were obese (Liou, Liou, & Chang, 2010). Among these adolescents, sleep habits were a significant predictor of increased obesity risk for those who slept less than 7.75 h per day (Liou et al., 2010). Similarly, late bedtimes and decreased REM sleep have been associated with an increased risk of obesity in American teenagers (Hart et al., 2011). To address this issue, Meltzer (2010) has suggested that if an individual does not receive treatment, issues surrounding sleep will not spontaneously resolve, and these issues can continue to result in adverse health consequences.

Most but not all studies support an independent association between obesity and sleep from infancy to adolescence. One study did not support this relationship after controlling for gender, race, education, and family income (Hassan, Davis, & Chervin, 2011). However, targeting sleep behaviors has the potential to positively impact the health status of adolescents – particularly reducing the risk of obesity – at multiple developmental levels.

## Clinical Implications of Targeting Sleep Behaviors

A growing body of evidence supports the need for implementing sleep interventions in clinical settings as **one effective strategy for the prevention and treatment of childhood obesity in conjunction with healthy eating and activity**. Moreover, targeting sleep behaviors has further implications on weight status beyond simply improving sleep hygiene because correlations have been found between sleep duration and other known predictors of obesity. For example, individuals with shorter sleep duration often consume greater amounts of energy-dense foods, such as pizza or pasta, and increased food cravings have been found in individuals exhibiting more daytime sleep than nocturnal sleep (Hart et al., 2011). In addition, shorter sleep durations have been found in children who engaged in less physical activity and watched more than 3 hours of television per day (Padez, Mourao, Moreira, & Rosado, 2009). Predictors of obesity, such as sleep duration and television viewing, are often synergistic and, therefore, can increase the odds of

being overweight even further (Taveras et al., 2008). Since many of the predictors of obesity overlap, improving lifestyle behaviors that target any one of the predictors has the potential to result in additional health improvements related to the other predictors, therefore creating a more substantial impact on an individual's health status.

## Methods

We conducted a comprehensive search of three online databases (PubMed, Cumulative Index to Nursing and Allied Health Literature [CINAHL], and Ovid MEDLINE). Various combinations of the following terms, subject headings, and search parameters were used in the search: *obesity; childhood obesity; sleep interventions; sleep hygiene; infancy; childhood; adolescence; bedtime routines*. The search was limited to articles published in peer-reviewed journals from 1995 to the present. The inclusion criteria for this review were (1) studies of children in all developmental age groups (0 to 18 years), (2) studies published between 1995 and 2012, (3) studies that implemented sleep interventions or evaluated predictors of sleep, and (4) studies with outcome measures that included total sleep time, sleep onset latency, frequency/duration of night wakings, and sleep hygiene/habits. Three hundred seventy-three articles were identified that met our inclusion criteria. The titles and abstracts of these 373 articles were reviewed for relevance. On further review only articles addressing sleep intervention were retained and articles addressing theory, predictors of sleep, and reliability and validity of measures were excluded. Nine studies were included in our final review.

## Results

The nine studies reviewed included a variety of interventions that can be utilized to influence sleep duration and counteract sleep problems (Table 1). Three main intervention areas were identified that comprise bedtime routines and environment, parental presence and graduated extinction, and health education.

### Bedtime Routines and Home Environment

Four of the nine studies have demonstrated the importance of (1) routine in regulating sleep throughout childhood and (2) providing an environment which facilitates healthy sleep behaviors. Mindell, Telofski et al. (2009) evaluated the impact of a strict bedtime routine for infants and toddlers that involved a bath, a massage or application of lotion, and a quiet activity each night. The routine was completed within 30 min. Compared to the control group, the bedtime routine resulted in decreased sleep onset latency, decreased number and duration of night awakenings, increased sleep continuity,

and decreased perception of sleep as a problem by the parents (Mindell, Telofski et al. (2009)). Additionally, among toddlers, a bedtime routine decreased the number of times the child left his or her crib or bed and improved his or her mood upon awakening per parental report (Mindell, Telofski et al. (2009)). Using responses from a questionnaire evaluating sleep hygiene behaviors, Mindell, Meltzer et al., 2009 found that lack of a bedtime routine and a late bedtime resulted in longer sleep onset latency, shorter sleep duration, and increased frequency of night awakenings. In addition, the inclusion of reading as part of the bedtime routine was predictive of longer sleep duration; in contrast, the presence of a television in the room resulted in shorter sleep duration (Mindell, Meltzer et al., 2009). Hale et al. (2011) also emphasize the importance of utilizing language-based bedtime routines, such as reading, singing, praying, or talking. Children whose families utilized language-based bedtime routines slept for 9.6 h per night compared to the 9.4 h of children in families who did not (Hale et al., 2011).

Additional elements of the home environment can be modified to improve sleep in children in all age groups. For example, in toddlers, the absence of a daily nap can result in longer sleep onset latency (Mindell, Meltzer et al., 2009). Additionally, consumption of one caffeinated beverage per day can predict less nighttime sleep in preschoolers and school-aged children (Mindell, Meltzer et al., 2009). Billows et al. (2009) found that greater family disorganization was significantly associated with longer sleep onset latency, increased daytime sleepiness, and decreased total sleep time in adolescents. However, this association was observed when controlling for the presence of sleep hygiene behaviors such as diet, physical activity, daily sleep routines, caffeine intake, and light and noise levels (Billows et al., 2009). Overall, a higher level of parental involvement and more rules (e.g., no caffeine and less video gaming before bedtime) were associated with healthier sleep behaviors in adolescents (Billows et al., 2009).

### Graduated Extinction and Parental Presence

In infants, toddlers, and children, parental presence while falling asleep was associated with later bedtimes, longer sleep onset latency, less total sleep time, and more frequent night awakenings (Mindell, Meltzer et al., 2009; Mindell et al., 2010). Because parental behavior is highly associated with a child's sleep habits, parents can learn strategies to enhance the sleep habits of their children. One of these is known as *graduated extinction*. This is a behavioral technique that can be taught to parents to be utilized in the home environment. The technique involves ignoring tantrums or difficulties at bedtime for a preset time interval, which is increased weekly. For example, if a child is throwing a tantrum at bedtime in his or her room, the parent does not enter the room. At the end of the interval, the parent briefly enters (i.e., < 15 s) and before leaving provides the child with verbal reassurance (Ramchandani et al., 2000). In their systematic review, Ramchandani et al. (2000) assert that interventions that utilized graduated extinction resulted in

**Table 1** Summary of sleep interventions in children.

Author (Year)	Study Design	Sample Size (n)	Age	Intervention	Outcomes	Summary of Results
Billows et al. (2009)	Descriptive	217 adolescents	13 to 18 years	Online questionnaire	-Family disorganization -Sleep hygiene -Sleep onset latency (SOL) -Daytime sleepiness (DS) -Total sleep time (TST)	-Family disorganization was associated with longer SOL, increased DS, and decreased TST -Controlling for sleep hygiene explained the relationship between family disorganization and SOL, DS, and TST
Eckerberg (2002)	Randomized controlled trial	67 children (36 boys, 31 girls)	Mean age = 9.8 years	Instructed about graduated extinction; compared personal consultations and telephone follow-up to written information received by mail	-Child's ability to fall asleep independently at night and following night wakings	-No significant differences between groups, both initial protests before sleep and night wakings decreased -Parents reported satisfaction with written information
Hale, Berger, LeBourgeois, and Brooks-Gunn (2011)	Longitudinal	4274 children	Birth to 5 years	Statistical analyses to determine association between language-based bedtime routines and sleep duration	-Language-based bedtime routines (e.g., singing, reading, praying, talking) -Nighttime sleep duration	-Children in families who utilized language-based bedtime routines slept statistically significantly longer than families who did not (9.6 h vs. 9.4 h)
Kerr, Jowett, and Smith (1996)	Randomized controlled trial	86 families	3 months to 9 months	Provided health education booklet about settling methods and importance of routine at 3 months; evaluated intervention and control group at 9 months	-Settling difficulties -Night waking (nights per week and times per night)	-21% of the infants in the intervention group had settling difficulties at 9 months (control group = 39%) -23% of the infants in the intervention group woke up 2 or more nights per week at 9 months (control group = 46%) -Positive response from parents to booklet
Mindell, Meltzer, Carskadon, and Chervin (2009)	Descriptive	1473 parents or caregivers	Birth to 12 years	Questionnaire	-Sleep onset latency -Frequency of night wakings -Total sleep time -Sleep hygiene patterns	-Consistent bedtime routines correlated positively with longer total sleep times in all age groups -Late bedtimes in all age groups resulted in a longer sleep onset latency and slept less per night -Parental presence while falling asleep resulted in shorter total sleep time, longer sleep onset latency, or more frequent night wakings in all of the age groups -Reading at bedtime predicted less night wakings in infants and longer total sleep time in other age groups whereas a TV in the room resulted in less total sleep time -Absence of a regular nap for toddlers resulted in longer sleep onset latency -Consuming one caffeinated beverage per day predicted less nighttime sleep in preschoolers and school-age children

Mindell, Telofski, Wiegand, and Kurtz (2009)	Randomized controlled trial	405 mother–infant pairs	7 to 36 months	Evaluated impact of a strict bedtime routine (e.g., bath, massage/apply lotion, quiet activity, and lights out within 30 min) on child sleep in comparison with control group of normal routine	<ul style="list-style-type: none"> <li>-Sleep onset latency</li> <li>-Frequency and duration of night wakings</li> <li>-Total sleep time and length of longest continuous sleep period</li> <li>-Total naps per day</li> <li>-Parental report of sleep as a problem and infant mood in morning</li> </ul>	<ul style="list-style-type: none"> <li>-In both infants and toddlers, a bedtime routine resulted in decreased sleep onset latency, decreased frequency/duration of night wakings, increased sleep continuity, and decreased parental perception of sleep as a problem</li> <li>-In toddlers, a bedtime routine resulted in decreased number of times a child called out or climbed out of bed as well as improved mood upon awakening</li> </ul>
Mindell, Sadeh, Kohyama, and How (2010)	Descriptive	29,287 parents	0 to 36 months	Internet-based questionnaire	<ul style="list-style-type: none"> <li>-Nighttime sleep duration</li> <li>-Daytime sleep duration</li> <li>-Longest continuous sleep period</li> <li>-Frequency of night wakings</li> </ul>	<ul style="list-style-type: none"> <li>-Length of nighttime sleep was explained by bedtime, falling asleep independently, and having a bedtime routine</li> <li>-Children who fell asleep independently obtain more total sleep, experience night wakings less frequently, have less difficulty falling asleep at bedtime, and are perceived as having fewer sleep problems</li> </ul>
Ramchandani, Webb, and Stores (2000)	Systematic review of randomized controlled trials	9 studies (5 non-drug trials)	Birth to 5 years	Literature review	<ul style="list-style-type: none"> <li>-Frequency of night wakings (time per night and per week)</li> <li>-Length of settling time</li> </ul>	<ul style="list-style-type: none"> <li>-Behavioral interventions demonstrated short- and long-term efficacy</li> <li>-Interventions included: education booklet, graduated extinction, bedtime routines</li> </ul>
Skuladottir, Thome, and Ramel (2005)	Quasi-experimental	79 infants	Mean age = 10.2 months	Education about promoting sleep: improve self-soothing abilities by reducing contact before assisting; reduce contact when putting infant to bed or during the night; keep child awake for at least 4 h before nighttime sleep; how to develop daytime routines	<ul style="list-style-type: none"> <li>-Duration of nighttime sleep</li> <li>-Frequency of night waking</li> <li>-Duration of daytime sleep</li> <li>-Length of last waking period</li> <li>-Settling time</li> </ul>	<ul style="list-style-type: none"> <li>-Nighttime sleep increased from 10.2 to 10.5 h per night</li> <li>-Frequency of night wakings decreased from 4.5 to 1.5 per night</li> <li>-Average daytime sleep increased from 2.5 to 2.9 h per day with an increase in the length of the last waking period from 4.4 to 5.4 h</li> <li>-Fewer parents reported settling issues</li> </ul>



decreased night awakenings per week. Similarly, an intervention that provided parents with written materials describing graduated extinction was also effective in improving sleep in children (Eckerberg, 2002).

## Health Education

Parents are responsible for their child's lifestyle behaviors during the early developmental period. Therefore, providing instruction to these parents in clinical settings as well as through educational resources that can be used in the home setting is an important aspect of health care. Skuladottir et al. (2005) evaluated the impact of a nurse-led intervention at an outpatient clinic that taught parents to promote day and night sleep in their infants. Techniques included (1) determining when and where the child took daily naps, (2) keeping the child awake for a minimum of 4 hours before nighttime sleep, (3) increasing the infant's self-soothing abilities by waiting lengthier periods of time before providing assistance, and (4) gradually reducing contact with the infant when putting him or her to sleep (Skuladottir et al., 2005). The intervention resulted in increased duration of night and daytime sleep, decreased frequency of night awakenings, and increased duration of last waking period before bedtime (Skuladottir et al., 2005). Additionally, fewer parents reported that their infants needed assistance falling asleep (Skuladottir et al., 2005).

Because one-on-one interventions in outpatient settings may not be possible due to time and cost constraints, alternative methods of health education have also been identified as effective in treatment of sleep problems. For example, Kerr et al. (1996) provided parents with a health education booklet when their infant was 3 months old. The booklet explained different settling methods and emphasized the importance of routine in regulating sleep. When sleep behavior was evaluated at 9 months, the infants in the intervention group had fewer settling difficulties and less frequent night awakenings compared to infants in the control group (Kerr et al., 1996).

To date, it turns out that the methods used in this health education delivery are not critical to their success. For example, Eckerberg (2002) compared the effectiveness of education regarding graduated extinction through personal consultations and telephone support with that of being delivered via written material. The results showed no significant difference between the groups as both settling difficulties and night awakenings decreased (Eckerberg, 2002). In addition, parental response about the usefulness and satisfaction with the written material was positive in both studies (Eckerberg, 2002; Kerr et al., 1996). Moreover, Ramchandani et al. (2000) found that additional support through telephone calls did not significantly affect health education about sleep behavior techniques through written material. Overall positive results were seen regardless of how the information was delivered.

## Implications for Clinicians

Health care providers are well positioned to implement the interventions identified in the literature as effective strategies for improving sleep throughout childhood because they are trusted professionals who establish long term relationships with families. However, health care providers may not be able to discuss or thoroughly investigate sleep behaviors on a regular basis in primary care settings. In a national survey, parents indicated that only 47% of doctors asked about their child's sleep, and only 13% inquired further about sleep problems in their children (National Sleep Foundation, 2004).

Both assessment of sleep behaviors at every developmental stage and developmentally appropriate education for parents and children about healthy sleep behaviors are critical needs in primary care. Because parents may not be aware of the health consequences of commonplace behaviors, the health of many children, especially related to sleep behaviors, suffers. For example, responses from a national survey indicated that over half of U.S. infants are put in their crib already asleep, and parents are present while 68% of infants, 43% of toddlers and preschoolers, and 23% of school-aged children fall asleep (NSF, 2004). As a result, these infants and children may be less like to acquire self-soothing abilities. Out of compassion, parents may prefer to remain in the room to provide comfort to their children, yet their presence may negatively affect their children's sleep. Health care providers need to thoroughly inquire about sleep-related behaviors such as parental presence and be prepared to provide education on not only behavioral interventions to enhance sleep quality, but also the health consequences of harmful behaviors.

In terms of improving sleep among children and the role of parents therein, research has identified several behavioral interventions that can be easily implemented and are effective in modifying sleep behaviors. Results of this research are consistent with recommendations from the American Academy of Sleep Medicine (Meltzer, 2010). These recommendations (Table 2) can be easily utilized as references by providers or in the development of educational resources for parents.

Interventions focusing on the establishment of good sleep practices have been referred to as "sleep hygiene" (Galland & Mitchell, 2010). Key elements required for effective sleep hygiene include establishing a consistent sleep schedule, including bedtime and wake time. In addition, a consistent routine or rituals for transitions to bedtime are important. Rituals such as verbal cues, a warm bath, and story time may be soothing for children. A routine incorporating such rituals should end in the child's sleeping environment, typically the child's bedroom, as part of the transition to sleep. Maintaining a calm, quiet, dark, and cool sleep environment is another important aspect of effective sleep hygiene (NSF, 2014). Primary care providers need to discourage the presence of televisions, videos and/or computers in the child's bedroom. Screen viewing should be specifically avoided within an hour prior to sleep as it is disruptive to

**Table 2** Recommendations for practice.Key Elements for **Effective Sleep Hygiene** During Childhood

1. Consistent sleep schedule
  - Set a consistent, age-appropriate bedtime
  - Enforce bedtime 7 nights per week
2. Consistent bedtime routine
  - Provide cues or warnings to child before transitioning to bedtime routine
  - Create a standardize bedtime routine, 20 to 30 min in duration with 2–3 activities
  - Can include, taking a bath, massage or application of lotion, or a quiet activity
  - Use language-based activities as part of the routine (e.g., singing, reading, playing a game)
  - Have routine end in child's sleeping environment
3. Teach child to fall asleep independently
  - Graduated extinction
4. Monitoring daytime nap and rest times
5. Activity extinction in preparation for sleep
  - Encourage daytime physical activity with quieter activities as bedtime approaches
  - Avoid strenuous activities for approximately 1 hour before bedtime
  - Avoid TV and computers in the bedroom
  - Engage in quiet activities such as reading before sleep
6. Dietary recommendations
  - Avoid caffeine beverages within 3 hours of sleep

Note. Adapted from Galland and Mitchell (2010); Meltzer (2010); NSF (2014).

sleep and is associated with an increased risk for overweight and obesity. The sleep–wake cycle is regulated by light and dark and screen viewing disrupts this cycle, adversely influencing mental and physical development (National Sleep Foundation (NSF) (NSF), 2014). Parents should be advised to monitor child daytime habits such as encouraging daytime physical activity; limiting extended daytime napping and avoiding caffeine beverages within three hours of bedtime. Strenuous physical activity and play should be avoided for approximately one hour before bedtime (Galland & Mitchell, 2010). Ultimately, it is important to tailor patient education materials to meet the needs of the practice setting and population in order for them to be effectively utilized.

## Conclusion

A significant correlation between **children obtaining adequate sleep and obesity** has been clearly demonstrated ( $p = .004$ ) (Anderson & Whitaker, 2010). **Shortened sleep relative to average sleep duration or “curtailed sleep” from infancy through school age has been associated with higher overall and central adiposity** (Taveras, Gillman, Pena, Redline, & Rifas-Shiman, 2014). As the prevalence of obesity continues to grow, innovative strategies to target its prevention and treatment must be developed. Obesity may be

effectively targeted by placing a greater emphasis on providing education about sleep to families in primary care settings. Behavioral interventions, such as instructing parents on the importance of bedtime routines or techniques to improve a child's self-soothing abilities not only are effective strategies for improving sleep behaviors, but also can easily be implemented in primary care settings.

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